Plan of Action
for
Drainage to the San Luis Unit
Central Valley Project

APRIL 18, 2001

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PLAN OF ACTION

Reclamation will initiate immediately a detailed review of all reasonable alternatives for providing drainage service to lands within the San Luis Unit. The schedule for completion is provided on Attachment A. The process will involve a Feature Reevaluation and environmental review to assess all viable alternatives for economic feasibility and environmental impacts and/or benefits. Key issues that will be addressed during the Feature Reevaluation include the scope of authority under the original San Luis Unit, State and Federal permit requirements, and final approval process. Completion of the Feature Reevaluation and environmental review will result in a decision on how to proceed with providing drainage service within the San Luis Unit. The project approval process, budgetary issues and a detailed project construction time line will be addressed in the Feature Reevaluation documentation report. Schedule and milestones for the Feature Reevaluation/environmental review are provided below.

Feature Reevaluation/Environmental Review

The environmental review will be conducted pursuant to the National Environmental Policy Act (NEPA), the Endangered Species Act and other applicable laws, to analyze the environmental impacts of implementing each of the feasible alternative means of providing drainage service to lands within the San Luis Unit. All reasonable alternatives as required by NEPA and its implementing regulations will be examined. Draft Environmental Impact Statements prepared in the early 1980's and in 1991 for drainage to the San Luis Unit will provide a useful beginning, thus allowing Reclamation to expedite completion of the analysis. Alternatives, with their related designs and cost estimates, identified in these earlier efforts as discussed below will be re-evaluated and updated to reflect current conditions. In addition, hydraulic modeling will be conducted to evaluate the waste discharge requirements associated with the various alternatives. Additional alternatives, or combinations of alternatives, for further consideration will be identified through a public scoping process. In addition, all necessary information required for obtaining permits including Section 404 Clean Water Act and Section 401 Water Quality certification will be acquired.

Reclamation has been engaged for many years with other State and Federal agencies as well as farmers, water districts, and other stakeholders, to develop effective, affordable, and implementable drainage solutions. Several of these efforts have resulted in innovative and promising techniques, and Reclamation is committed to continuing to support those approaches. However, the only proven technologies that have been identified to date to provide drainage and achieve sustainable salt balance on drainage-affected, irrigated lands in Westlands Water District are disposal of salts out of valley such as through completion and operation of the San Luis Drain, or disposal to evaporation ponds. Indeed, in comments on a draft of this plan to be submitted to the Court, the Peck and Westlands plaintiffs identified these as the only proven or effective methods of providing drainage. Whether these methods can be implemented in an affordable or environmentally permissible way remains to be determined, however, and Reclamation cannot prejudge the outcome of the analysis nor predict the ultimate viability of those alternatives. In separate comments, one set of plaintiffs suggested that the only viable alternative to completion and operation of the San Luis Drain is land retirement. As indicated above, all reasonable alternatives as required by law will be evaluated. Whichever alternative is chosen for implementation, Reclamation Law requires that the costs of the studies as well as construction be repaid by the beneficiaries.

Reclamation had developed plans and cost estimates for completing the San Luis Drain to a point near Chipps Island in the Sacramento-San Joaquin Delta in the early 1980's. (See attachment A) This analysis also developed plans and cost estimates for an evaporation pond alternative and a desalting alternative. The San Luis Drain alternative was identified as the least costly of the alternatives evaluated at that time, followed by the evaporation alternative. The estimated costs of completion of the San Luis Drain to serve the San Luis Unit and immediately adjacent areas, were updated to 1994 dollars and estimated at that time to be approximately $810 million. This did not include the treatment facilities that would likely be necessary in order to obtain a discharge permit. Treatment requirements and the associated costs remain to be determined.

Reclamation prepared a detailed plan for providing drainage to Westlands Water District via evaporation ponds in 1991 (See Attachment B). The estimated cost of those facilities at that time were approximately $1.5 billion, which included costs of wildlife protection measures that would likely be necessary to obtain discharge permits.

In addition to analysis of these alternatives, as noted above, other alternatives or combinations of alternatives will be identified through a public scoping process, and will be analyzed for potential adoption.

PLAN OF ACTION SCHEDULE

The Feature Reevaluation/environmental review is scheduled to be completed in about four years (see Attachment A). Completion of the scoping and alternative analysis and formulation process is anticipated to take approximately 20 months. It is estimated that economic, social, and environmental analysis of the alternatives and filing of a Draft Environmental Impact Statement will be completed within three years.   It is estimated that a Final EIS and Record of Decision will be completed in about four years. The key milestones are provided in the table below.

Milestone	Task	Schedule
MS1	Initiate NEPA/Project Planning	April 01
MS2	Issue Public Notice	June 01
MS3	Conduct Scoping Process (first public meeting)	August 01
MS4	Identify and Evaluate Alternatives	June-Nov 01
MS5	Identify Preferred Alternative	Dec 02
MS6	Draft Coordination Act Report	Apr04
MS7	Final Coordination Act Report	Oct 04
MS8	Complete Draft Reevaluation/EIS report	June 04
MS9	Public Hearings on Draft report	Dec 04
MS10	Complete Final documents and ROD	June 05

SHORT TERM CONTINUING ACTIONS

In addition to pursuing the plan of action to provide drainage service set out above, Reclamation will also voluntarily continue its partnerships with other State and Federal agencies and water users to pursue development and implementation of drainage management techniques consistent with the ongoing interagency San Joaquin Valley Drainage Implementation Program. Immediate or short-term actions are available that will reduce and manage drainage water to sustain agricultural productivity and environmental quality of the Valley while long-term solutions are evaluated and implemented. These actions have already proven to provide drainage benefits, or are likely to provide drainage benefits in the short term. Reclamation will work to assist any plaintiff or other landowner in the San Luis Unit in implementing these actions upon request. In December 2000, the eight State and Federal agencies that compose the San Joaquin Valley Drainage Implementation Program adopted a Drainage Management Strategy outlining a process to proceed with implementation of these sets of actions. Some of these actions have also been incorporated into the Stage 1 implementation of the Record of Decision for the CALFED Bay-Delta Program and will be considered for implementation during the next few years. Reclamation will coordinate through these institutional structures and with growers and water districts to continue to pursue these actions including:

- Continuation of Grassland Bypass Project and In-Valley Treatment Planning
- Implementation of Integrated On-Farm Drainage Management Systems
- Drainage Water Treatment
- Ground Water Management
- Source Reduction Projects
- Development of Enhanced Evaporation, Salt Harvest, Salt Utilization and Disposal Technologies

ATTACHMENT A

PROJECT SCHEDULE
PLAN OF ACTION
FOR
DRAINAGE TO THE SAN LUIS UNIT

ATTACHMENT B

DESCRIPTION
COMPLETION OF THE SAN LUIS DRAIN ALTERNATIVE

The following is extracted from U.S. Bureau of Reclamation unreleased draft report entitled *Special Report on Drainage and Water Service and Draft Supplement to the Final Environmental Statement, San Luis Unit, Central Valley Project, California*, dated June 15, 1984. All features described require reevaluation in light of current knowledge and conditions.

Completion of the San Luis Drain Alternative

A combination of a surface canal and underground pipeline would convey drainage effluent about 207 miles from Kettleman City north to the western Delta near Chipps Island. The concrete-lined canal would extend 193 miles from Kettleman City to a point near Oakley (4 miles southeast of Antioch) and would provide for gravity flow with an overall head differential of 210 feet. An underground, pressurized pipeline 14 miles long and 9 feet in diameter would be constructed from the northern end of the canal to a discharge point opposite Chipps Island. Details of the drain and related facilities are summarized in Table 1.

The capacity of the completed portion of the drain varies from 200 ft^3/s at Five Points to 300 ft^3/s at Kesterson Reservoir. The southern extension of the drain between Five Points and Kettleman City would be completed with a capacity ranging between 100 to 150 ft^3/s. The initial capacity of the northern extension from Kesterson Reservoir to Chipps Island would be 500 ft^3/s and the ultimate capacity 625 ft^3/s by year 2025. The completed portion of the drain has 87 road crossings. To regulate, divert, or stop drainwater flows, there are 67 check structures in the drain.

The pressurized pipeline could follow one of three alternative alinements. The preferred alinement extends along State Highway 4 through Antioch and Pittsburg. Because of extensive developments along the highway, however, two alternate routes will also be investigated -- an offshore alinement and a high-line alignment. Generally, the offshore alignment would follow

ATTACHMENT B

Table 1. San Luis Drain and related facilities

Feature	Size or number	Expanded service area	Authorized service area
Collectors, sumps, and carrier conduits (service to Westlands only)	10-51 in. dia.	45,000 acres (initial) 225,000 acres (ultimate)	45,000 acres (initial) 225,000 acres (ultimate)
Canal:			
Kettleman City to Five Points	29.5 mi	100-150 ft3/s	100-150 ft3/s
Five Points to Kesterson Reservoir	84.8 mi	200-300 ft3/s	200-300 ft3/s
Kesterson Reservoir to Oakley	77.8 mi	500 ft3/s (initial) 625 ft3/s (ultimate)	360 ft3/s
Oakley Reservoir	150 acres	750 acre-feet	750 acre-feet
Oakley Pumping Plant	8/6 units (initial)	23,500 hp	7,200 hp
	10 units (ultimate)	29,250 hp	
Pipeline	14.2 mi	500 ft3/s (initial) 625 ft3/s (ultimate)	360 ft3/s
Diffuser	48 in.	8,000 feet	5,000 feet
Regulating reservoirs:			
Mendota	3,700 acres	7,600 acre-feet	7,600 acre-feet
Dos Palos	3,700 acres	19,000 acre-feet	15,600 acre-feet
Tracy	1,110 acres	8,100 acre-feet	-----
Emergency storage reservoirs:			
Kesterson	1,610 acres	4,200 acre-feet	4,200 acre-feet
Byron	500 acres	2,700 acre-feet	2,700 acre-feet

the Highway 4 route to the vicinity of Oakley and then diverges to the channel west of Big Break from Antioch Bridge to Chipps Island for a total distance of 14 miles. The high-line alinement would extend west from a point 6.8 miles south of Oakley generally along the right-of-way for the Mokelumne Aqueduct to the vicinity of Antioch Municipal Reservoir, then along streets and roads to intersect the Highway 4 alinement northeast of Los Medanos College. This alinement is about 20 miles long.

Detailed study on the alinement would be required before a final selection can be made.

Oakley Reservoir would serve as a pumping plant forebay at the terminus of the canal portion of the drain. It would be sized to handle variations in flow along the drain or a power outage at the Oakley Pumping Plant. The reservoir would minimize fluctuations of the inlet water-surface elevation for the pumping plant. The reservoir would be sized to a maximum volume of 750 acre-feet with a surface area of approximately 150 acres.

The reservoir site is rectangular in shape and is bounded by Contra Costa Canal on the north, Marsh Creek on the west, and Cypress Road on the south. Surface elevations range from 15 feet in the southwest corner to 5 feet at the northeast corner.

Oakley Reservoir would be formed by earth embankments constructed from material excavated from the reservoir bottom. The reservoir would have a lining to prevent potential seepage and contamination of area ground-water supplies. Normal water-surface elevation would be about 13 feet, and water depth would average about 5 feet. Because the water surface of the canal would fluctuate with the reservoir water surface, additional freeboard and concrete lining would be required along the northernmost 14 miles of the canal. The surcharge capacity would be about 450 acre-feet. As a public safety precaution, the reservoir would be enclosed by chain link fencing.

If the canal portion of the drain between the Byron and Oakley Reservoir sites were located at a lower elevation, Oakley Reservoir might not be required and instead Byron Reservoir would be enlarged and operated as a flow-through reservoir. This possibility would be evaluated during preconstruction activities.

Pumping plant: Oakley Pumping Plant would be housed in a reinforced-concrete structure. It would have a capacity of 500 ft^3/s, and multiple pump units would be manifolded into a 108-inch-diameter discharge line. About 290 kilowatt hours (kWh) of electrical energy would be required for every acre-foot pumped. The discharge line would extend west about 23,000 feet to a 150-foot-diameter regulating tank located near Highway 4. From there flow would be by gravity to the discharge point at Chipps Island.

The design for Oakley Pumping Plant would be governed by the alinement selected for the pipeline. The Highway 4 alinement would require a pumping lift at ultimate capacity of about 314 feet, and the high-line alinement would require a lift of 318 feet. For either alinement, energy would have to be dissipated in the vicinity of the discharge point. The offshore alinement would also require a pumping plant, and the pumping lift associated with this plant is about 80 feet. Pumping lift is defined as the combination of elevation head and friction head to be overcome.

Diffuser: A diffuser system has been conceptually designed to ensure a 10:1 dilution of the discharging drainage effluent. The diffuser would extend over an area of 1.8 million square feet. The diffuser would provide for extension of the pipeline from the shoreline near Mallard Slough approximately 300 to 400 feet into Suisun Bay. A header pipe 108 to 84 inches in diameter would be constructed perpendicular to the end of the pipeline and extend parallel to the shoreline for approximately 900 feet on each side of the pipeline. Eight diffuser pipes spaced at 250-foot intervals along the header pipe would extend into the bay as shown in figure 1. Each diffuser pipe would be 4 feet in diameter and approximately 1,000 feet long. Riser pipes 4 inches in diameter would be spaced at 15- to 20-foot centers along each diffuser pipe.

A detailed engineering design would be required for the diffuser system. Specialists in the design of discharges into estuaries would assist with the design to ensure that the objectives were achieved.

<u>Alternative discharge location</u>: An alternative discharge location in the vicinity of Middle Point approximately 4 miles west of Chipps Island would be considered. The pipeline alinement would parallel the Santa Fe Railroad which lies immediately south of a brackish-water marsh. The alternative location, shown in figure 2, could allow for a multiple discharge facility throughout the 4-mile reach and would also involve a diffuser located near Middle Point to handle total anticipated discharge.

<u>Emergency storage reservoirs</u>: Two emergency reservoirs would be developed to ensure that any drainage water suspected of being contaminated could be accumulated over a 10-day period and treated. After treatment, the drainage water would be returned to the drain.

One of the reservoirs, Byron, would be constructed north of Clifton Court Forebay near the downstream end of the drain canal as shown in figure 3. Byron Reservoir would cover 300 acres to a depth of 10 feet and provide about 2,700 acre-feet of active storage. Because the reservoir would be infrequently (if ever) used, and for no longer than 30 days each time, a lining may not be necessary.

The other emergency storage would be provided by the existing first stage of Kesterson

Reservoir. To be utilized as an emergency facility, Kesterson would not function as a flow-through regulating reservoir as designed, nor would it serve as an evaporation pond as it is [then] currently being used. The existing 1,240-acre first stage of Kesterson Reservoir, with a 4,200-acre-foot capacity, would be sufficient to handle the volume of water generated from the service area south of the reservoir.

<u>Treatment facilities</u>: Treatment facilities will likely be necessary to meet discharge requirements imposed by the State Water Resources Control Board. Since the extent to which the drainage water would be treated is unknown, no specifics on treatment were developed.

<u>Rapid toxicity monitoring facilities</u>: A continuous biological monitoring system would be installed to detect high levels of toxic substances which might be discharged into the drain. This warning system would allow adequate time for appropriate remedial actions to prevent environmentally harmful discharges into Suisun Bay. Devices would be installed at three separate locations along the drain.

<u>Regulating reservoirs</u>: Regulation capability of about 50,000 acre-feet would be designed into three shallow reservoirs that would be located near Mendota, Dos Palos, and Tracy. These reservoirs, shown in figures 3 and 4, would be constructed for seasonal storage during any year when the beneficial uses of water within the western Delta-Suisun Bay area would be adversely affected by a discharge from the drain. A permanent water-quality monitoring program for the area would be implemented. The reservoirs would be constructed if the proposed monitoring program demonstrated that constituents in the drain discharge would, under future project conditions, adversely affect beneficial uses of the receiving water.

The design of the regulating reservoirs would be similar to the design of the initial phase of Kesterson Reservoir. Figure 5 shows a typical plan view of a shallow regulating reservoir. The reservoirs would not be lined unless a need for frequent use is indicated. They would store drainage flows for at least 2 months during May through August for gradual release during the remainder of the year and would have maximum capacities as indicted below:

	Maximum water-surface area (acres)	Active storage (acre-feet)	Evaporation loss (acre-feet)	Total regulative capacity (acre-feet)
Mendota	2,600	7,600	6,800	14,400
Dos Palos	2,600	19,000	8,000	27,000
Tracy	950	8,100	2,200	10,300
Total	6,150	34,700	17,000	51,700

Seepage control: A ground-water monitoring program would be implemented along the drain and at reservoir sites.

Where natural ground-water movement would be interrupted by a project feature, provisions would be included to assure that movement would not be impeded. Where it is anticipated that seepage from a project feature would adversely affect beneficial uses, special preventive measures would be used such as underdrains, diversions ditches, interceptor wells, compacted linings, and subsurface interceptor drains with pump wells. A typical section of the drain canal showing parallel interceptor drain and observation wells is depicted in figure 6.

Problems that develop during project operation would be corrected by remedial measures. Examples range from plugging cracks and adding bentonite to the soil behind the concrete lining to design modification and partial reconstruction.

Severance: To the extent possible, the drain would be located on properties in such a way as to reduce or eliminate access problems. The drain alinement has been proposed along property boundaries as much as is practical. As designs become more detailed through field investigations, the input of potentially affected landowners, local government, and utilities will be reflected in modifications and refinements to the alinement.

Bridges would be constructed at county and State highway crossings and where access for operation and maintenance would be necessary. If economically justified, farm bridges would be constructed to restore access to severed parcels. Where bridges are not feasible, other means of access would be explored, such as construction of roads to the nearest bridge. Access through operation and maintenance roads can also be granted to the landowners. These considerations would be made in design and construction of the drain.

Irrigation and drainage crossings would be constructed where necessary so that the movement of water could continue uninterrupted as much as practicable.

Drain collection systems: A portion of a drain collection system has been constructed within Westlands to convey subsurface drainage from 8,000 acres of farmland to the San Luis Drain. Additional facilities would be needed and would probably be similar to those already constructed.

The drainage collection system includes onfarm drains, collector pipes, and carrier conduits, as shown in figure 7. Onfarm drains–-typically perforated plastic pipe–-are installed 7 to 11 feet below the ground surface in rows spaced approximately 300 feet apart. Water applied to crops must filter through 7 to 300 feet of earth before entering the onfarm drains. The onfarm drains discharge–usually by gravity flow–into collector drains.

The collector drains consist of concrete pipe placed open jointed so that additional inflow can be picked up as the pipe carries the drainage delivered by onfarm drains. In Westlands, the collector drains discharge by gravity flow either directly into a carrier conduit or into pump standpipes. Drainage water is pumped from a standpipe either into a carrier conduit or directly into the drain. Carrier conduits are closed jointed and deliver drainage water by gravity flow to the drain. Collector pipes and carrier conduit have been installed to serve 45,000 acres. An additional 180,000 acres will require collection facilities.

ATTACHMENT C

DESCRIPTION
EVAPORATION POND ALTERNATIVE

ATTACHMENT C

The following is extracted from U.S. Bureau of Reclamation report entitled *Plan Formulation Appendix, San Luis Unit Drainage Program*, dated December, 1991. All features described require reevaluation in light of current knowledge and conditions.

Evaporation Pond Alternative

Overview of Alternative

In Westlands, up to 179,000 acres of drainage-affected land would be provided drainage service involving construction of new on-farm tile systems and district tilewater collection facilities. Portions of existing but unused tile systems and collection facilities would be reactivated, and the SLD would be extended to the south. Evaporation ponds would be used to separate solids from tilewater with solids placed in a dedicated landfill for final disposal.

In the northern districts, facilities would be provided to enable disposal of tilewater to the San Joaquin River in compliance with water quality objectives. This would involve constructing South Grassland bypass facilities, a northern extension of the existing SLD, and district-level tilewater recycling facilities.

Westlands Water District

System Capacity and Operational Concept

The capacity of the drainage service facilities would be established by the capacity of the evaporation ponds. They would be sized to accomplish a net evaporation of 60,000 acre-feet annually, requiring 15,000 acres of pond water surface. The collector system would be sized to handle a maximum flow of 0.43 gpm. per drained acre or 138 gpm for a typical 320-acre tile system. The capacity of on-farm tile systems would be as determined by individual farmers, but their instantaneous discharges would be limited by the collector system capacity (0.43 gpm/acre) and annual discharges by the capacity of the evaporation ponds (60,000 acre-feet).

Facilities operation would be driven primarily by on-farm agricultural production decisions by individual growers. Growers would be able to discharge tilewater on schedules that best meet their needs, considering cropping pattern, soil characteristics, groundwater quality, and irrigation practices, subject to the capacity constraints described above. Inasmuch as the capacity of the evaporation ponds would vary over time according to weather conditions and other factors, pond capacity would need to be determined and allocated to dischargers from time to time, such as on a monthly or seasonal basis.

Salts dissolved in tilewater would precipitate from solution as water was evaporated from the ponds. Precipitated salts would accumulate on the pond bottoms and would be removed and landfilled when a sufficient depth (1 to 2 feet) had developed.

ATTACHMENT C

Drainage Service Area

The drainage service area and facilities layout are illustrated in Figure 1. The service area encompasses a total of 200,600 acres including about 75 percent of the existing 42,000-acre drainage area; the remaining 25 percent of the existing drainage area would be occupied by the evaporation pond complex as described below. This delineation covers most of the lands currently affected by problem water, defined as shallow groundwater within 5 feet of the ground surface and of such quality that crop production is reduced or production costs are increased (SJVDP, 1990).

On-Farm Tile Drainage Systems

On-farm tile drainage systems would be configured basically like those typically used in agriculture, but with appropriate features added so that tilewater discharge to the collector pipelines could be controlled. This control would typically be at the pump connection to the collectors because no gravity connections would be allowed. A typical farm connection is illustrated in Figure 2. Flow would be controlled by throttling or on/off control of the pump. Additional controls might be required in the tile lines themselves to avoid or minimize potential damaging effects caused by underground "ponding" in the low portions of the tile system. This problem and its control using DOS-IR valves are illustrated in Figure 3. Another possible method of control would be to install tile lines at shallower depths (and closer spacing) so that less groundwater is collected. It should be noted that drainage control using DOS-IR valves and shallow tile placement is still in the testing stage with results showing only partial effectiveness. On-farm drainage control would be the responsibility of individual growers.

Approximately 4,000 acres of existing tile systems in Westlands would be reactivated; another 1,000 acres would be covered by evaporation ponds (Figure 4). In the latter case, the drains would be either demolished or incorporated into the design and operation of the ponds. Drains reactivated for agriculture might need to be retrofitted with controls to minimize ponding effects caused by restricting tile discharges.

Tile Drain Installation and Tilewater Discharge

Individual growers would decide when and where to install drains within the drainage service area, subject to specific technical requirements that would assure compatibility with operation of the collector and pond facilities. Projections were made of the rates at which farmers would choose to install tile drains. The projections were based on a comparison of on-farm drainage costs with benefits. The installation decision does not consider the cost of drainwater disposal. If a significant portion of disposal costs are charged to drainers as a fee per acre-foot drained, total costs of drainage would rise substantially, and the rate of drain installation would correspondingly drop. If total costs of drainage exceed the additional net revenue attainable from drained land, then drains would not be installed and land would eventually drop from full production.

The projections show that existing (but currently non-operating) drainage systems would be reactivated immediately followed by gradual installation of new systems. New systems would be installed first on the most saline lands because the benefits of drainage would be greater there. Drains would be installed at a rate of about 10,000 acres per year for the first 10 years and would slow to about 3,000 acres per year during the subsequent 25-year period.

Projections were also made of the quantity of tilewater that would be discharged from farms. Those projections were based on the installation rates described above and the assumption that tile systems would have controls to facilitate shallow water table management. Such controls would enable farmers to benefit by increasing the contribution to crop evapotranspiration from the shallow water table, in turn reducing irrigation demand. Under these conditions, the projections show that tilewater discharge would ramp up quickly to 24,000 acre-feet within the first 5 years. Thereafter, the rate of increase would slow to about 1,200 acre-feet per year. The initial rapid increase is explained by tile systems being installed first in the shallowest water table areas where water tables would be drawn down to a more desirable level. The drainage yield during that initial period would be on the order of 0.4 acre-foot per acre per year. Thereafter, drainage yields would be lower-approximately 0.3 acre-foot per acre because less water would be removed from storage on lands going under drainage.

The projected quality of tilewater would improve over time, rapidly at first, and then more slowly as soils are reclaimed. The projections represent the blended average tilewater salinity, reflecting the various lengths of time different areas would have been drained and the assumed pattern of highest salinity levels being drained first. Although some analyses suggest that tilewater would be initially very saline, a limit of 15,000 mg/l TDS was imposed as a practical upper limit for extensive drained areas. After 17 years, the average TDS would be approximately 4,000 mg/l; new lands would still be coming under drainage at that time. In 35 years, when drainage installation has ceased, tilewater salinity would be approaching an equilibrium salinity of about 3,200 mg/l.

The mass load contained in tilewater would be the product of tilewater quantity and TDS. Mass load is projected to increase rapidly while salinity and drainage yields, and installation rates are high, to about 250,000 tons per year. Mass load would decrease gradually to about 200,000 tons per year in 17 years and would then increase gradually to an equilibrium level of 260,000 tons per year in 35 years. The average mass load over the initial 50-year period would be 227,000 tons per year.

Tilewater Collection Facilities Including Existing Portions and Extension of the San Luis Drain

The drainwater collection system would consist of buried watertight pipelines. Those portions of the existing collection system located south of California and east of Derrick Avenue (serving about 10,000 acres) would be abandoned; the remaining portions (serving about 32,000 acres) would be retrofitted to make them watertight. They were originally constructed with open joints so as to collect shallow groundwater. Such uncontrolled interception would not be compatible with operation of the evaporation ponds. A new force main would be constructed along the west side of the pond complex to convey tilewater from the retrofitted collectors to the high part of the ponds at the southwest corner. Five pump stations, one at the terminus of each existing collector, would be constructed to pump water into the force main. A total of 1,680 horsepower would be installed at these stations.

Additional collector pipelines would be constructed to serve new tile-drained lands. These would typically be installed at 1-mile intervals running from west to east along the section lines. Manhole connections, 36 inches in diameter, would be constructed with new collector lines and retrofitted as needed on existing lines. The location of manholes would correspond to the final selection of tiled lands. Tilewater would be pumped from farm tile systems into manholes as previously described. Collector pipe diameters would range from 6 to 24 inches. PVC pipe would be used.

The SLD would be extended 27.6 miles to the south from its existing terminus, approximately 6 miles east of Five Points. The alignment shown (Figure1) is the same as previously planned by Reclamation (1972). The canal would have a 2-1/2-inch-thick non-reinforced concrete lining with 11/2:1 side slopes. Two sections would be used for the extension. The southernmost 13.8 miles would have a bottom width of 2.0 feet, a depth of 2.0 feet, and a design capacity of 25 cfs. The northern 13.8 miles (connecting to the existing SLD) would have a bottom width of 4.5 feet, a lined depth of 2.0 feet, and a design capacity of 50 cfs. Both sections would have 1.5 feet of freeboard.

Collector lines would flow by gravity to terminal wet wells from which tilewater would be pumped into the SLD. A total of 85 hp would be installed at 12 of these low lift stations. Tilewater would flow northward in the SLD by gravity to a new 3,000-hp main pump station located at the southeast corner of the pond complex (Figure 1). A new 60-inch-diameter force main would convey tilewater from the pump station to the high point of the pond complex at the southwest corner. The existing SLD north of the main pump station would not be used.

Evaporation Ponds

A net pond surface area of 15,000 acres would be required to achieve the design capacity of 60,000 acre-feet per year based on an annual net evaporation of 4.0 acre-feet per acre. A gross land area of 16,500 acres (approximately 26 square miles) would be occupied by the pond complex, including area for roads, dikes, and maintenance areas. The ponds would be located adjacent to and west of the SLD, approximately 5 miles south of Mendota. This site is purposely located near the Mendota Wildlife Management Area so that birds unable to land on the evaporation ponds, because of netting, would have readily available alternate landing areas (Figure 1).

The ponds would be constructed with features that avoid or minimize adverse environmental impacts, including the following:

- Lining to minimize seepage and potential degradation of groundwater
- Overhead netting to eliminate access by waterfowl
- Fencing to minimize access by other wildlife
- Subsurface perimeter drains to intercept offsite flow of pond water
- Minimum freeboard of 1.5 feet to minimize risk of overtopping

Linings would be constructed from compacted earth or buried membranes, whichever is more economical, depending primarily on native soil conditions. Both lining methods could be used, if desired. Overhead netting would be supported by a system of cables strung between simple steel or wood columns.

It should be noted that netting is not required for existing agricultural drainage ponds in the San Joaquin Valley. Netting is included as a feature of San Luis Unit ponds, however, because it eliminates exposure to waterfowl and requirements for offsite mitigation. Costs may be reduced by providing water to offsite mitigation areas rather than netting.

The ponds would be constructed with a system of internal diking to form cells of approximately 60 to 80 acres each. Internal concrete-lined distribution ditches would enable delivery of tilewater to each pond independently from the others. Water would be added to the ponds intermittently so that, on average, inflow would equal evaporation. Initial evaporation rates would be essentially the same as for freshwater, but as TDS concentrations rose, the evaporation rate would decrease. It is estimated that at peak concentrations, evaporation would be reduced to approximately 65 percent of freshwater evaporation, other factors being the same. A steady-state rate of 4.0 acre-feet per acre was used for planning purposes.

The rate of precipitate accumulation in the ponds would depend on the TDS concentrations in the incoming tilewater and precipitate density. Using the previously presented tilewater TDS trends and an estimated precipitate density of 1.4 grams per cubic centimeter, the rate of accumulation would be approximately 0.04 foot per year during the initial 5-year period and about 0.01 foot per year thereafter. It is estimated that it would take about 85 years for salts to accumulate to a depth of 1 foot and nearly 200 years to reach a 2-foot accumulation. Thus, salt removal would not start until the ponds had been in operation for at least 40 years.

Landfill Facilities

Regulations. Significant uncertainty remains regarding the application of state and federal regulations to landfilling salts removed from drainage water. The SJVDP (1989) could not determine if the wastes would be classified as hazardous waste or designated, pursuant to state criteria, because of a lack of waste analysis information. CH2M HILL has concluded that the waste materials probably would be classified as a designated waste, rather than a hazardous waste, based on estimated concentrations of arsenic, molybdenum, and selenium. However, CH2M HILL has also concluded that because of the lack of measured quantities of the contaminants and uncertainty in the way agencies may interpret regulations, the possibility of classification as a hazardous waste cannot be eliminated. Federal and state land disposal restrictions would also apply. Federal Land Disposal Restrictions would specifically restrict land disposal of the waste salts if the concentration of arsenic in waste extract (Toxicity Characteristic Leaching Procedure-TCLP) is equal to or greater than 5.0 mg/l, or if the concentration of selenium in waste extract is equal to or greater than 5.7 mg/l. At these concentrations, the wastes would be classified as hazardous by toxicity characteristics and would be assigned EPA Hazardous Waste No. D004 (arsenic) or D010 (selenium). These hazardous waste numbers are listed in the land disposal restrictions, under the "third third" category, effective August 8, 1990.

It is possible that the waste salts could be classified as a hazardous waste under federal regulations and not be subject to the land disposal restrictions. For example, a selenium concentration of 1.0 mg/l in waste extract would make the waste hazardous by toxicity characteristics but, if the waste extract selenium concentration was less than 5.7 mg/l, the waste would probably not be subject to the federal "land ban" restrictions, provided there were no other hazardous constituents present above the restriction concentrations.

Uncertainty in application of regulations to this alternative probably will remain until detailed chemical analyses of the waste materials are completed and discussions are held with regulatory agencies. Those steps should definitely be taken if the evaporation alternative becomes the preferred plan. For purposes of preparing comparable alternatives, it was assumed that regulatory requirements could be satisfied so that solid wastes could be placed in a properly constructed Class II landfill facility.

Siting. Comparative analyses indicate that it would be much more economical to place waste materials in a dedicated facility rather than a commercial facility receiving various other waste materials. Previous studies have reviewed potential landfill siting areas within 100 miles of the Mendota area and concluded that there are many possible locations and general areas that may be suitable for a landfill site. This was determined primarily through a review of County Hazardous Waste Management Plans. Because the Hazardous Waste Management Plans were supposed to consider state landfill siting criteria when selecting potential siting locations, it is assumed that the basic siting criteria were met. The Fresno County Hazardous Waste Management Plan identifies areas near Mendota as being potentially acceptable for siting a materials repository.

Groundwater throughout the evaporation pond area is estimated to be at a depth of 5 to 10 feet below the land surface. It has been estimated that these levels may drop over time when lands are removed from irrigation. The state regulations (CFR, Title 23, Section 3, Subchapter 15, Article 3, Waste Management Unit Classification and Siting) require that "All new landfills, waste piles, and surface impoundments shall be sited, designed, constructed, and operated to ensure that wastes will be a minimum of 5 feet above the highest anticipated elevation of underlying ground water." Therefore it will probably not be possible to design and construct the landfill to be partially below the ground surface. On the other hand, because it appears that groundwater exists below the 5-foot level, the landfill can probably be constructed essentially at the ground surface without additional site buildup or underdrain systems to maintain the 5-foot separation requirement.

A review of soil classifications and characteristics was conducted to assess the types of soil in the area of the terminal ponds. This information was derived from the unpublished report *Soil Survey for Western Fresno County, California*, 1991. The report was prepared by the United States Department of Agriculture, Soil Conservation Service but has not been completed and published as of this writing.

In order to assess the nearest location that may be suitable for siting a landfill, the areas immediately to, the east, north, and west of the evaporation ponds were reviewed. Those areas consist primarily of clays and clay loams. Permeabilities range from 1.41 x 10-3 cm/sec to less than 4.23 x 10-6 cm/sec. By comparison, the state minimum standard for landfill liners is 1 X 10-6 cm/sec for Class II (and 1 X 10-7 cm/sec for Class I facilities). With compaction, native soils probably could meet the Class II clay liner requirements.

The soils in the area are, however, probably not suitable for other aspects of landfill construction. The clays are hard to excavate and handle, have low strength, and have high shrink-swell potential. This makes the soils poor for use as daily cover, and not well suited for construction of berms and roads. Additional soil will probably have to be imported for those purposes. This is not a fatal flaw in siting the landfill; few landfill sites have suitable soil for construction of all landfill features and often either clay must be imported for the liners or soil imported for construction and daily cover. The poor characteristics of the local soils as a daily cover is another reason to use an alternate daily cover such as plastic, or if approved, no daily cover.

In conclusion, it appears that the groundwater and soil conditions are acceptable in the area of the evaporation ponds to site an above grade landfill, provided that a source of appropriate soil can be located for the construction of berms and roads.

Construction. Actual construction of landfill capacity would be delayed until salt removal from ponds began, ranging from 40 to 80 years after initial operations. For project planning purposes, the analysis assumes that construction occurs 40 years into the period of analysis. The configuration of the landfill would depend on the site selected, size and shape of the land parcel, proposed operation and maintenance methods for the facility, and height restrictions to minimize visual impacts. The landfill facility could be constructed as a series of cells with several years of capacity per cell, or be constructed as a single unit. If the single unit approach is selected, construction of the containment berms would be accomplished as additional capacity is needed, as opposed to building the entire containment area initially. This would help minimize the maintenance of berms built in advance and would allow termination and closure of the landfill at any time without wasted construction costs.

The required acreage would depend on several factors including the average depth of the salt emplaced, the amount of soil used as cover material, and the size and configuration of the landfill containment berms. It was assumed that soil cover would be limited to only 10 percent of the salt volume. In normal solid waste landfills, it is more common to have a much higher percentage of soil. However, most solid waste landfills handle putrescible wastes that must be covered with soil on a daily basis. The estimate of 10 percent soil cover is based on assumptions that no putrescible wastes will be handled at the salt landfill and that some alternate daily cover, such as plastic sheeting, would be used during most of the operations. It is also possible that the daily cover requirement could be waived for a properly designed and operated salt landfill.

The size of the berms necessary to contain the landfill will vary depending on the final design of the landfill. The percentage of the required acreage that will be occupied by the berms will be a function of the depth of the salt and the size of the landfill cell(s). It was estimated that adding 30 percent to the required landfill acreage would approximate the total land requirements.

Finally, it was assumed that the landfill height would be limited to 30 feet to minimize visual impacts. Based on these assumptions, approximately 4.4 acres of land would be needed each year to construct landfill capacity for storing the average annual salt mass of 227,000 tons.

Thermal Evaporation Sub-Alternative

As described above, this alternative features solar evaporation ponds to separate dissolved solids from tilewater because ponds are currently estimated to be less expensive than thermal evaporation using cogeneration. However, ponds or cogeneration could serve the same function in the process. Because the costs of thermal evaporation are highly uncertain and could decrease in response to decreases in natural gas costs or increases in energy prices, it should be maintained as a sub-alternative as planning proceeds. Thermal evaporation could be used in lieu of or in conjunction with ponds. If used together, tilewater would first be concentrated in ponds and then sent to thermal evaporation for final separation of solids. Two advantages of thermal evaporation compared to ponds are reduced land requirements and elimination of potential waterfowl exposure to drainwater. A disadvantage is that the waste stream of solid salts must begin immediately with startup, compared to evaporation ponds where landfilling could be postponed until 40 years or more after startup.